

On the Specificity of Madras Backwater Oyster *Crassostrea madrasensis* Preston and the American Oyster *Crassostrea virginica* Gmelin¹

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(With two text-figures)

Several conchological and malacological characters were studied in two oysters viz., *Crassostrea madrasensis* Preston and *Crassostrea virginica* Gmelin, to find out whether they are synonymous as indicated by earlier workers. The studies indicate that these are two distinct species though apparently of close similarity.

INTRODUCTION

Whatever little is known about the systematics of oysters of the Indian coast is confusing. Recently the author (Durve 1967) attempted to clarify this confusion and place the two well-known backwater oysters of India into two distinct species namely *Crassostrea madrasensis* Preston and *Crassostrea gryphoides* (Schlotheim). However, this work does not clarify the position of *C. madrasensis* as a synonym of the American oyster *C. virginica* Gmelin, as opined by Vredenburg and reported by Annandale and Kemp (1916) and also by Hornell (1918, 1949 and 1951).

Preston (1916) had, of course, observed the close similarity between *C. madrasensis* and *C. virginica* (= *Ostrea canadensis* LK.) but noted that the Indian backwater oyster (*C. madrasensis*) is of a straighter form and thinner texture and is much foliaceous externally. The left valve is more concave and the inner margins of both valves as well as the muscular scars are of a dark purple colour. He thus considered the Madras oyster as a distinct species namely *O. (C.) madrasensis*. Gravely (1941) and Satyamurthi (1955) supported the identification by Preston. In view of this controversy, it was felt desirable to study the conchologica¹ and mala-

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cological characters of *C. madrasensis* and *C. virginica* to establish the correct identity of the former.

A sample of *C. virginica* was obtained from the U.S. Shellfish Advisory Service. The soft parts of this sample of 4 medium-sized oysters were received preserved in Davidson's fixative while their shells came dry, cleaned and properly numbered. Though the sample was small, there is a considerable literature available on this oyster which could be profitably used for the present study. A sample of twelve specimens of *C. madrasensis* from Ennore backwaters near Madras was obtained from the Southern Regional Station of the Zoological Survey of India. In all 28 different characters both from the shell and soft parts of *C. madrasensis* and *C. virginica* were studied and compared. All the measurements reported in this paper have been taken by a vernier calliper and fine mathematical divider.

OBSERVATIONS AND REMARKS

There is a diversity of opinion regarding the validity of any character in a highly variable form like an oyster. It is well known that the so-called diagnostic characters of oysters undergo considerable changes due to the environment; with the result, at times, the same species passes under several names. However, recently, there have been attempts to standardize these characters. In spite of this, the so-called generally constant characters do show deviations. For instance, the deep cup-shaped nature of the left (lower) valve has been generally reckoned as a diagnostic character; but the author has seen this being altered due to the environment such as bottom contour, surf beaten coast-line with exposed or semi-exposed rocks etc. Galtsoff (1964) states 'size, shape, curvature and proportion of the beak *i.e.*, the pointed (dorsal) end of an oyster shell, are useful generic characters, but like other parts of the shell they are variable and cannot be entirely depended upon for identification.' He also states 'the position of the muscle scar and its outline differs in various species and therefore, is used as a taxonomic character.' But, records considerable variations in the scar shapes in the individuals of the same species *i.e.*, *C. virginica*. The author has also observed differences in the scar-shapes in the specimens collected from the same locality but different substrata. However, it is felt that the scars in general may show some constancy in shape which could perhaps be specific.

Thomson (1954) and Galtsoff (*op. cit.*) observed that the soft anatomy of the oyster is not very variable but its taxonomic usefulness is limited. However, Thomson found several characters of the soft anatomy useful in his work on Australian oysters. The usefulness of the different conchological and malacological characters in the classification of oysters has

been well discussed by Thomson and Galtsoff. So far as the oysters of the present investigation are concerned, it was possible to separate some characters out of 28 examined; which showed appreciable differences leading to the understanding of the species.

The following characters were found to differ appreciably in *C. virginica* and *C. madrasensis* though in the case of some characters there was slight similarity in a few individuals.

Conchological characters	Malacological characters
1. External sculpture on the right (upper) valve.	1. The shape of adductor muscle.
2. Coloration of the external surface of the shell.	2. The position of anal opening in relation to the adductor muscle.
3. Internal coloration of the shell-valves.	3. The nature of anal opening.
4. The recess below the beak of the left (lower) valve and its depth.	
5. The shape and colour of the muscle-scar.	
6. The width and depth of the hinge-area (beak) groove in the lower valve.	
7. The colour of hinge ligament.	

These characters are dealt with separately below.

CONCHOLOGICAL CHARACTERS

1. *External sculpture on the right (upper) valve :*

The sculpture of the shell is a greatly variable character depending on local conditions. In oysters of the present study, it was found that *C. madrasensis* was much more foliaceous externally than *C. virginica*. The extent of growth fringes in both the species varied considerably in different specimens. The comparison of the external sculpture of *C. virginica* when made with *C. madrasensis* collected from Athankarai estuary near Mandapam also confirmed the earlier inference. Galtsoff (1964) states that the external sculpture in the American oyster varies greatly and supports this by a few figures of this oyster collected from different localities on the coast of America.

2. *Coloration of the external surface of the shell :*

While no taxonomic significance is attached by Galtsoff (op. cit.) to the external coloration, Thomson (op. cit.) states, 'For each species there is a range of pigment patterns and a range of shades of colour from which specimens do not vary though they may overlap the range

of another species.' Iredale (1939) attempted to use coloration for taxonomic purpose.

In the case of *C. madrasensis*, the pattern of coloration ranged from one uniform colour to the various mixtures of 3-4 different colours, patches of one or more colours to their localization on different portions of the surface. In the case of *C. madrasensis*, the normal colours are purple, white, brown and their various shades. The white colour is invariably restricted to the top surface of the right valve and also the sides of the left valve which may be due to the bleaching of this portion by sunlight in the case of exposed or semi-exposed specimens. The purple colour is generally in the form of suffusion and at times in patches or streaks. The brown colour is invariably restricted to the growth fringes.

In *C. virginica*, white and brown or blackish-brown colours are predominant. The purplish shade is slight and is obliterated by blackish-brown shade. Sides of the lower valve are white with brownish and purple shades.

3. Internal coloration of the shell-valves :

Internal coloration, according to Thomson (op. cit.), is specifically constant. He feels that there may be only one colour or ranges of a few shades characteristic of each species.

In *C. madrasensis* the internal coloration is white but almost always it has purple around the whole or part of the margin. This coloration is absent in the middle portion of both the valves and also near the hinge region. The coloration ranges from light pink-purple and deep purple to almost black. The deeper colour is invariably restricted to the ventral margin facing the posterior portion of the gill, especially in the case of the lower valve. The purple coloration is generally about 5 to 10 mm inside from the edge of the shell. Thus a strip of 5 to 10 mm left towards the edge is almost invariably pure white and nacreous. The purple coloration of the margin appears to be a constant feature of this species as it was also noticed in the case of specimens collected from Athankarai estuary near Mandapam.

In the case of *C. virginica*, the internal coloration is pure white or nacreous white with yellowish patches here and there only in some specimens.

4. The recess below the beak of the left (lower) valve and its depth :

The recess below the hinge of the lower valve has been known to be of taxonomic value. In *C. madrasensis*, the recess beneath the beak is invariably very well developed. In specimens examined for the present study, it ranged from 2 to 10 mm in depth. Individuals having the recess depth of more than 2 mm were in majority. In *C. virginica* the maximum depth of the recess recorded in the sample received from U.S.A. was 4.00 mm and the minimum was 1.00 mm.

5. *The shape and colour of the muscle scar :*

The shape and colour of the adductor impression varies with species. There is a variation even in the individuals of the same species. However, the general shape and coloration could be regarded as more or less constant for any species. In *C. madrasensis*, the shape of the scar varies with the individual but is either elliptical, transversely broad or oblong ; the last two being more or less overlapping. In case the scar is roundish in any specimen, its one end will invariably taper to a blunt point. Only in rare cases a broad bean-shaped scar occurs. Its colour is always more or less deep black. No light bands or patches have so far been noticed by the author on the scar.

On the other hand, the shape of the scar in the case of *C. virginica* is almost roundish, somewhat bean-shaped with the dorsal margin of the scar having slight concavity in the centre. The differences in the dimensions of the scars from both the valves in these two oysters are thus obvious. Galtsoff (op. cit.) however states that the shape of the muscle scar in *C. virginica* is a variable character and to some extent reflects the shape of the shell. The colour of the scar in *C. virginica* is light to deep purple but never deep black as in *C. madrasensis*. The colour may be uniformly purple or deep purple bands may alternate with lighter bands. At times, the colour is spotted with lighter sprinklings.

6. *The width and depth of the hinge area groove in the lower valve :*

From the casual observation of the shells of *C. madrasensis* and *C. virginica*, it was felt that the groove in the centre of the beak or hinge area is narrow and shallow in the case of the former. When the actual measurements were taken it was found that narrowness of the hinge area groove is not specific. However, its depth though could not be measured, appeared to be constantly more in the case of *C. virginica* when compared with that of *C. madrasensis*.

7. *The colour of hinge ligament :*

The significance of the ligament in the systematics of bivalves in general has been studied by Bowerbank (1844), Jackson (1890, 1891), Dall (1889, 1895), Biedermann (1902) and others. The entire work in this direction has been well reviewed by Haas (1935). Recently, Thomson (op. cit.) made use of this character to separate two well-known Australian oysters namely *C. commercialis* and *C. tuberculata*. Galtsoff (1964) makes no mention of the significance of this character in the taxonomy of oysters.

In the case of *C. madrasensis*, the colour of the ligament was observed to be invariably black at two ends but brown in the central bulging portion. However, slight variations were also noticed in some oysters. In *C. virginica*, the ligament was found to be black in all the specimens of

the sample except one, where it was brownish-black in the central bulging portion. This character may perhaps prove to be of significance so far as the systematics of these two oysters is concerned.

MALACOLOGICAL CHARACTERS

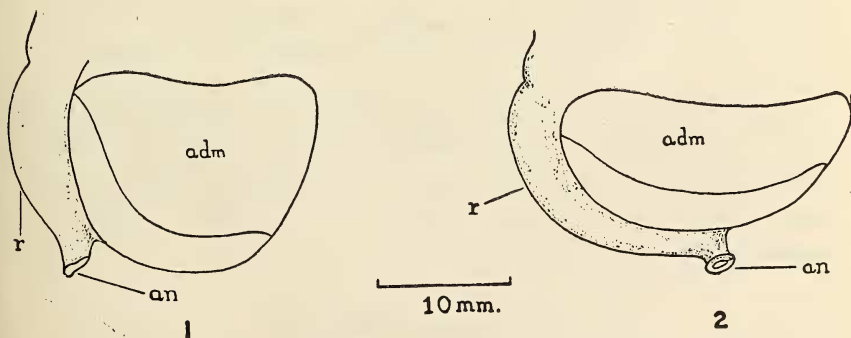
8. *The shape of the adductor muscle :*

The adductor muscle does not have the taxonomic significance. Thomson (op. cit.) used the relative proportions of the catch and quick areas of this muscle for the separation of genera. However, Hopkins (1930) has reported that this ratio of catch and quick areas with each other depends on ecological conditions.

The shape of the adductor muscle was found to be more or less constant in two species of oysters studied for this investigation. It was either elliptical or oblong in the case of *C. madrasensis* and almost round—slightly flat and concaved on the dorsal margin, in the case of *C. virginica*.

9. *The position of anal opening in relation to adductor muscle :*

This feature was found to differ in the two oysters under investigation. Along with the position of the anal opening, the size of the rectum differs. It was noticed that the size of the rectum (from the dorsal margin of the adductor to the anal opening) is more in the case of *C. madrasensis* than in *C. virginica* except in one or two specimens. The position of the anus also differs. In *C. madrasensis*, the opening is always invariably situated about the middle of the ventral margin of the adductor muscle while in *C. virginica*, it is at the corner of the posterior and ventral margins of the adductor (Fig. 1). This character has not so far been used in the systematics of oysters.

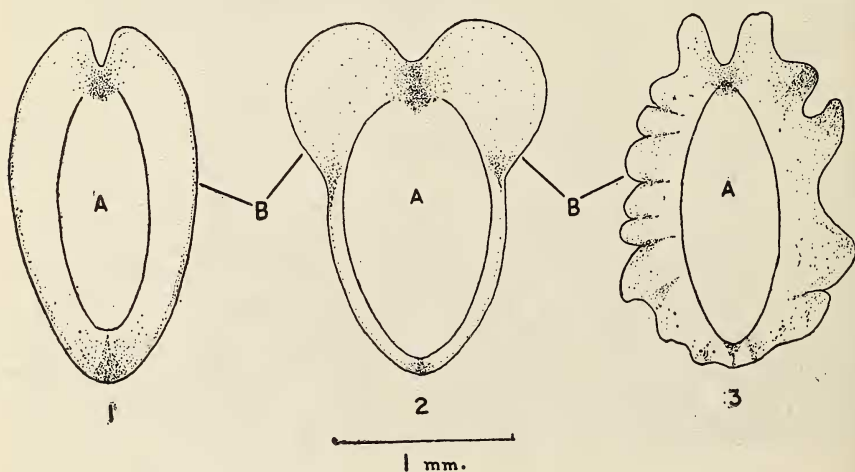


C. virginica *C. madrasensis*

Fig. 1. Anal opening in relation to adductor muscle.
r—Rectum; adm—Adductor muscle; an—Anus.

10. *The nature of anal opening :*

This character appeared to be strikingly different in the two oysters *viz.*, *C. madrasensis* and *C. virginica*. In the case of former, the opening is not simple. The wall of the anus is extra-ordinarily thickened and turned backwards forming a sort of collar to the anal opening. This collar is thinner at one end of the anal opening forming a small notch (Fig. 2). This collar is not always tightly folded but at times is loose and lessens in width at one end giving an appearance of a valve-like structure attached to the anus. The collar was noticed to have folds and lobed appearance in two specimens. The three varieties of collars observed in the sample of 12 specimens of *C. madrasensis* have been figured in Fig. 2. Only in one individual the anus was observed to be simple. In the case of *C. virginica*, the anus is simple, without any collar. This character has also not so far been used in the systematics of oysters.

Fig. 2. Anal opening in *C. madrasensis*.

A—Anal opening ; B—Collar.

From the account given above, it could be noticed that the two oysters *viz.*, *C. madrasensis* and *C. virginica* which were earlier considered as synonymous by some workers have several striking differences which could separate them into two distinct species. These differences have been tabulated below.

CONCHOLOGICAL CHARACTERS

<i>C. madrasensis</i>	<i>C. virginica</i>
1. More foliaceous externally.	Less foliaceous externally.
2. More variously coloured externally.	Less coloured externally.

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|---|--|
| 3. Purple suffusion or streak around the internal margins and especially in the region opposite the posterior portion of the gills. | Internal surface pure white. |
| 4. The recess beneath the hinge area (beak) in the lower valve invariably very well-developed. | The recess not very well-developed. |
| 5. The shape of the muscle scar is generally elliptical or oblong. | The shape of the muscle scar generally reniform (bean-shaped) or even roundish. |
| 6. Colour of the muscle scar almost deep black. | Colour of the muscle scar ranges from light to deep purple but never deep black. |
| 7. The central groove of the hinge area shallow. | The central groove of the hinge area comparatively deep. |
| 8. Colour of the ligament is black at sides but brown in the central bulging portion. | Colour of the ligament is generally black throughout. |

MALACOLOGICAL CHARACTERS

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| 9. The adductor muscle is either elliptical or oblong. | The adductor muscle is either roundish or bean-shaped. |
| 10. The size of rectum generally large. | The size of rectum generally small. |
| 11. Anal opening situated about the middle of the ventral margin of the adductor muscle. | Anal opening situated at the corner of the posterior and ventral margins of the adductor muscle. |

In view of the above differences in two oysters viz., *C. madrasensis* and *C. virginica*, the description of the former given by the author (Durve 1967) could be slightly amended in respect of the development of the recess beneath the hinge-area (beak) of the lower valve. When the type of *C. madrasensis* was compared with the type of *C. gryphoides* var. *cuttackensis*, the recess in the former was found to be less developed than in the latter. In the present investigation, this recess in *C. madrasensis* was noticed to be better developed when compared with its counterpart in *C. virginica*. However, such a thing could be expected in a comparative study and does not alter the systematic position of the oysters.

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REFERENCES

- ANNANDALE, N. & KEMP, S. (1916): Fauna of Chilka lake. *Mem. Indian Mus.* 5(4): 348-349.
- BIEDERMANN, W. (1902): Untersuchungen über Bau und Entstehung der Molluskenschalen. *Jenaische Jenaische Zeitschrift für Naturwissenschaft*, Neue Folge, Band 29: 1-164.
- BOWERBANK, J. S. (1844): On the structure of the shell of molluscus and conchiferous animals. *Trans. Micr. Soc. London* 1: 123-154.
- DALL, W. H. (1889): On the hinge of Pelecypods and its development with an attempt towards a better subdivision of the group. *Amer. J. Sci.*, Sr. 3, 38: 445-462.
- (1895): Contribution to the tertiary fauna of Florida, with special reference to the Miocene siliceous-beds of the Caloosahatchie river. Part III. A new classification of the Pelecypoda. *Trans. Wag. Free Inst. Sci. Phila.* 3, pt. 3: 479-570.
- DURVE, V. S. (1967): On the nomenclature of two Indian backwater oysters. *J. Mar. biol. Ass. India* 9(1): 173-178.
- GALTSOFF, P. S. (1964): The American Oyster *Crassostrea virginica* Gmelin. *U.S. Fish. Bull.* 64.
- GRAVELY, F. H. (1941): Shells and other animal remains found on the Madras beach. *Bull. Madras Govt. Mus.* N.S.—Natural History section 5(1).
- HASS, F. (1935): Bivalvia. Teil 1. Dr. H. G. Bronns Klassen und Ordnungen des Tierreichs. Band 3: Mollusca; Abteilung 3: Bivalvia, Akademische Verlagsgesellschaft, Leipzig, 984 pp.
- HOPKINS, H. S. (1930): Muscular differentiation in oysters exposed for diverse periods of time (Abstract). *Anat. Rec.* 47(3): 305.
- HORNELL, J. (1918): The edible Molluscs of Madras Presidency. *Bull. Madras Fish. Dept.* 11: 12.
- (1949): The study of Indian Molluscs, Pt. III. *J. Bombay nat. Hist. Soc.* 48(4): 750-774.
- (1951): Indian Molluscs. Bombay Natural History Society, p. 58-60.
- IREDALE, I. (1939): Mollusca: Pt. I, *Sci. Rep. Gr. Barrier Reef Exped.* 5(6): 209-245.
- JACKSON, R. T. (1890): Phylogeny of the Pelecypoda. The aviculidae and their allies. *Mem. Boston Soc. Nat. Hist.* 4(8): 277-400.
- (1891): The mechanical origin of structure in Pelecypods. *Amer. nat.* 25(289): 11-21.
- PRESTON, H. B. (1916): Report on a collection of Mollusca from the Cochin and Ennur backwaters. *Rec. Indian Mus.* 12: 27-39.
- SATYAMURTI, S. T. (1956): Mollusca of Krusadai island (in the Gulf of Mannar)—II—Scaphopoda, Pelecypoda and Cephalopoda. *Bull. Madras Govt. Mus.*, N.S.—Natural History Section 1(2), Pt. 7: 1-202.
- THOMSON, J. M. (1954): The genera of oysters and the Australian species. *Aust. J. Mar. Freshw. Res.* 5(1): 132-168.